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Cellular Decomposition and Classification of a Hybrid System

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Abstract

Robots are often modeled as hybrid systems providing a consistent, formal account of the varied dynamics associated with the loss and gain of kinematic freedom as a machine impacts and breaks away from its environment.

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Aaron M. Johnson and D. E. Koditschek*

Robots are often modeled as hybrid systems providing a consistent, formal account of the varied dynamics associated with the loss and gain of kinematic freedom as a machine impacts and breaks away from its environment [1]. This hybrid structure induces an abstract simplicial complex indexed by the active contact constraints, where each vertex in the complex is a single constraint. This complex provides a concise description of the possible edges of the hybrid system through impacts – they must lie in the closure of the star of the current cell (i.e. $(I, J) \in \Gamma \Leftrightarrow J \in \mathrm{Cl}\,\mathrm{St}\,I$). This structure is in some sense dual to the "ground reaction complex", [2], wherein constraints reduce dimension and the equivalent adjacency property is instead the star of the closure (i.e. $(I, J) \in \Gamma \Leftrightarrow J \in \mathrm{St}\,\mathrm{Cl}\,I$). Under either formulation, sequences of contact conditions ("letters") define smooth families of executions ("words"). Points of discontinuity lie within the boundaries between words, but in certain cases the evaluation can still be continuous over an open set including these boundaries, even though the associated words change abruptly. We present examples of these "convergent" and "divergent" word boundaries.

References

[1] A. M. Johnson, S. A. Burden, and D. E. Koditschek, "A hybrid systems model for simple manipulation and self-manipulation systems," 2014, in prep.
[2] A. M. Johnson and D. E. Koditschek, "Toward a vocabulary of legged leaping," in *Proceedings of the 2013 IEEE Intl. Conference on Robotics and Automation*, May 2013, pp. 2553–2560.

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